Physics & Astronomy Colloquium

Presents

Doerte Blume

Professor
The University of Oklahoma

Thursday, September 29, 2022
12:10 pm, Webster Room 11

Please meet our guest speaker and share in refreshments 11:45 a.m. -12:10 p.m. in the foyer on floor G above the lecture hall

"Wave guide QED: Collective behaviors of two-level emitters coupled to a non-linear bath"

Building on the tremendous successes of cavity quantum electrodynamics (QED), wave guide QED plays a key role in a plethora of quantum technologies. The coupling of one or more excited multi-level emitters to a continuum of electromagnetic modes leads, in most cases, to irreversible correlated radiation dynamics. Quite generally, the strong transverse confinement in a waveguide speeds up the radiation dynamics compared to the free case. Moreover, the directionality of a one-dimensional waveguide facilitates the build-up of correlations (or anti-correlations) between emitters that are separated by distances larger than the natural wave length of the wave guide, leading to superradiance, subradiance, and entanglement generation.

This talk investigates the collective dynamics of two non-interacting two-level emitters that are coupled to a structured wave guide that supports two-photon bound states. Tuning the energy of the two emitters such that they are in resonance with the two-photon bound state energy band, we identify parameter regimes where the system displays fractional populations and essentially undamped Rabi oscillations. The Rabi oscillations, which have no analog in the single-emitter dynamics, are attributed to the existence of a collective polaron-like photonic state that is induced by the emitter-photon coupling. The full dynamics is reproduced by a two-state model, in which the polaron-like state interacts with the state |e,e,vacuum> (two emitters in their excited state and an empty wave guide) through a Rabi coupling frequency that depends on the emitter separation. Our work demonstrates that emitter-photon coupling can lead to an all-to-all momentum space interaction between two-photon bound states and tunable non-Markovian dynamics, opening up a new direction for emitter arrays coupled to a waveguide. Our theoretical findings apply to a number of experimental platforms and the predictions can be tested with state-of-the-art technology. Extensions to an array of non-interacting emitters, including the emergence of localized stationary droplet states, will also be discussed.

References: J. Talukdar and D. Blume: Phys. Rev. A 105, 063501 (2022) and 106, 013722 (2022).

Host: Dr. Qingze Guan

ZOOM Information: Meeting ID: 965 8240 9398• Passcode: physastro